EXPOSURE

1) TITLE: Environmental Justice Saturation Monitoring of Selected Pollutants in Wilmington, California

BACKGROUND: Air quality data are essential to characterize a community's exposure to air pollutants; however, air quality data (criteria pollutants and air toxics) collected at any environmental justice (EJ) community are very limited, typically at relatively few (one to five) locations due to the cost of traditional monitoring technologies. Thus, there is a concern that air quality monitoring location(s) may not reveal exposure to hot spots. In addition, the spatial resolution of most air quality data is relatively coarse (a single monitor for tens of square miles) compared to the spatial resolution of socioeconomic status (SES) data. To capture real exposure in the community, air quality data of finer spatial resolution that are compatible with SES data are needed.

PREVIOUS WORK: In order to address these issues, the ARB is currently sponsoring a project being conducted by Professor Manuel Pastor of the University of California, Santa Cruz that will develop a framework that takes into account cumulative exposure, a more comprehensive model of vulnerability at the community level including environmental, demographic, and SES factors, and develop a screening tool for regulators and others to identify areas in need of special policy attention and community outreach.

OBJECTIVES: The objectives are to: 1) complement the UC Santa Cruz project and provide an air quality data set that is of comparable spatial resolution as SES data for EJ analysis, 2) collect spatially resolved data in order to identify hot spots of selected pollutants, their magnitude and spatial extent, and relative importance to regional background, 3) collect data of sufficient spatial and temporal resolution to allow comparison with fine-scale modeling results, and 4) demonstrate the use of low cost monitoring technologies.

DESCRIPTION: Low-cost monitoring technologies such as passive monitors will be used in this project to collect data on selected toxics in Wilmington at different locations each season or for a long period (one year is desired). The selected monitors will be validated before and during the field study against conventional monitoring technologies for accuracy and precision. The monitoring sites to be determined, including hot spot identification, will be determined based on criteria defined by ARB in consultation with the Pastor study team, including consideration of demographic and socioeconomic data, existing emission inventories, and model simulations. The number of sites will be determined so that the concentration gradients from potential hot spots can be delineated and some of the sites will be equipped with monitors for PM and selected toxics with better temporal resolution. Potential pollutants to be measured include nitrogen oxides, PM, key toxics and other pollutants.

BENEFITS: This project is intended to collect extensive spatial and temporal data to identify hot spots of selected pollutants in Wilmington and determine the concentration gradient in the area primarily from stationary as well as mobile and area sources. The data set collected is also intended to combine with socioeconomic status data for EJ analysis and allow comparisons with previous emission inventory and dispersion modeling results. The results of this project are expected to improve our understanding of actual exposure level at an EJ

community. The methodology developed from this project can be applied to other EJ communities.

2) TITLE: Determination of the Community-Scale Spatial Variability of Ultrafine Particles

PROBLEM: Measurements of ambient ultrafine particle concentrations at a single central monitoring station may not be indicative of human exposure in the communities surrounding a single monitoring site. Due to their short atmospheric lifetimes and strong dependence on very local sources, ultrafine particle numbers vary significantly on very small spatial and temporal scales. In order to address this problem and more accurately determine human exposure and the subsequent health impacts of ultrafine particles, more intensive particle number measurements on finer spatial scales is needed.

PREVIOUS WORK: Recent studies have demonstrated that ultrafine particles are more toxic than PM10 and PM2.5. Other studies have shown that individual particles are capable of penetrating cellular membranes and causing cell damage, suggesting that particle number rather than particle mass may be more indicative of potential health effects. A previous jointly-funded ARB/AQMD study measured ultrafine particle number concentrations at each of the Children's Health Study (CHS) communities at a single central monitoring station in each community. Results showed very predictable daily and seasonal patterns. But other studies showing that ultrafine particle concentrations vary dramatically within 100 meters of roadways point out the need for more spatially resolved ultrafine monitoring within impacted communities.

OBJECTIVE: The objective is to better determine the spatial variability of ambient particle number concentrations and thus improve estimates of human exposure to ultrafine particles.

DESCRIPTION: Using 10-12 of the condensation particle counters (CPC) the intracommunity variability of ultrafine number concentrations can be determined. The CPCs will be deployed at 10-12 individual sites within the cities of Wilmington and Riverside and within a 1-3 mile radius. Sampled communities will be chosen based on specific pollution characteristics and problems. Other communities will be chosen to correspond to CHS communities, allowing for comparisons to historical central site data and to CHS health outcomes. Two to three communities per year will be examined. The deployments will be accompanied by several meteorological instruments recording highly time-resolved wind speed, wind direction, humidity and temperature data. Such information can be used with the CPC continuous number data to identify local sources based on wind speed and direction. An upcoming EPA-funded project will fund this type of analysis as well as additional analyses examining the short- and long-term variations of highly time resolved number concentration data using techniques similar to Fourier transform analysis.

BENEFITS: Better information on the local-scale variability and sources of ultrafine particles will improve our understanding of human exposure to and the health impacts of this unregulated pollutant. Such information will lead to more effective control measures and/or ultrafine particle standards that will reduce the public health risk.

3) TITLE: Mobile Monitoring of Ultrafine Particulate Matter and Related Co-Pollutants in Community, Near-Roadway, and Roadway Locations

PROBLEM: Ultrafine particulate matter (PM) is potentially the most harmful component of particulate air pollution, but exposure data are lacking. Measurements near freeways have shown sharp concentration gradients, making fixed-site monitoring of limited value for ultrafine PM. Spatially resolved exposure data is needed to evaluate the health impacts of ultrafine PM.

PREVIOUS WORK: Animal exposure studies have found lung damage from ultrafine PM and human studies have found that ultrafine PM directly enters the bloodstream. Monitoring studies have found high concentrations and sharp gradients near roads and freeways. A pilot study that used the Mobile Monitoring Platform (MMP) concept extended this work by outfitting an electric vehicle for similar field measurements. Ultrafine PM concentrations and size data, along with gaseous co-pollutants, were measured on roadways, in neighborhoods, and near Los Angeles International airport. Ultrafine PM concentrations on roadways were one to two orders of magnitude higher than most microenvironments, making in-vehicle time the route of most ultrafine PM exposure for people who commute via freeways.

OBJECTIVE: The objective is to extend the MMP approach to more fully characterize invehicle, near-freeway, near-arterial, and community gradients of ultrafine PM as well as copollutant concentrations. These data will then be used in estimates of ultrafine PM exposure in these important microenvironments.

DESCRIPTION: The MMP approach to measuring ultrafine PM and other high-gradient pollutants will be based on an electric vehicle platform with extensive instrumentation. Enhancements to the previous MMP capabilities will include improved, rapid-response ultrafine PM instrumentation with higher dynamic range and a portable gas chromatograph to measure volatile organic compounds. Measurements will focus on high- and low-diesel traffic freeways, high and low-volume arterial roads, and characterizing the effects of meteorology on impacts to downwind communities.

BENEFITS: The findings of this study will allow better estimates of ultrafine PM exposure for Californians to ultrafine PM and other combustion-related pollutants. A better understanding of freeways and community-level concentration gradients will be gained, as well as the differences in impacts from truck traffic versus gasoline-powered vehicle traffic. This new approach to monitoring also offers a versatile means to address questions that arise regarding the impacts of sources and exposures. For example, measurements will provide valuable baselines from which to judge the impacts of expansions at the Long Beach port and increased Mexican truck traffic, as well as the effect of reductions in diesel truck fleet emissions as the 2007 standards begin to take effect.

4) TITLE: Effects of Sound Walls and Tree Lines on Concentrations of Particulate Pollutants Above and Adjacent to Freeways in Residential Neighborhoods

PROBLEM: Sound walls and tree lines are often requested by communities as a way to reduce concentrations of particulate matter at neighborhood sites near freeways. However, data are not available to determine the effect of sound walls or tree lines under modern conditions or dispersion of particulate matter into nearby residential neighborhoods, or the

effect of sound walls or tree lines on particulate concentrations immediately above the freeway. Data collected could be used to characterize and reduce community exposure to air pollutants. A research project could partially address how emissions are dispersed and transported in the atmosphere and how physical structures such as sound walls affect pollutant dispersion and transport.

PREVIOUS WORK: In 1984, Caltrans studied carbon monoxide concentrations in neighborhoods adjacent to sound barriers. Carbon monoxide is a gas and would disperse differently than particulate matter that is subject to deposition. In addition, modern sound walls in general have become taller (14-16 feet high rather than 8-12 feet) since the 1984 study.

OBJECTIVE: The objective is to conduct experiments to determine how particulate matter disperses in the presence of sound walls and tree lines, as compared to control sites without sound walls or tree lines. Issues of interest include whether and to what degree particulate matter concentrates within the confines of sound walls and tree lines, thereby increasing exposure for vehicle occupants, how sound walls or tree lines may affect particulate matter concentrations and deposition in neighborhoods adjacent to freeways, and appropriate methods for modeling these effects using commonly available tools.

DESCRIPTION: Particulate Matter (PM) mass and size sampling will be conducted immediately above and alongside freeways with and without sound walls, and with and without tree lines. PM sampling will also be conducted at breathing levels at increasing distances from freeways. Compare results with modeling using common microscale dispersion models such as Caline4, and appropriate methods will be suggested for use of such models to predict particulate matter concentrations in the presence of sound walls or tree lines consistent with the results of monitoring.

BENEFITS: If sound walls or tree lines significantly reduce particulate matter, especially diesel exhaust particulate concentrations in neighborhoods or at school sites near major freeways, they could be considered as mitigation measures. If sound walls or tree lines significantly increase concentrations at roadway levels within the confines of the walls, particulate matter exposure to motorists may be increased. Developing and validating appropriate modeling methods would assist with determining the optimal size and configuration of sound walls or tree lines with respect to effects on particulate matter concentrations.

5) TITLE: Hourly Monitoring of Acrolein in Ambient Air and the Assessment of Short-term Exposure Risks to Acrolein in Areas Heavily Impacted by Vehicular Traffic

PROBLEM: Acrolein has been identified by the Office of Environmental Health Hazard Assessment (OEHHA) as a pollutant that can cause infants and children to be especially susceptible to illness. ARB's current method (MLD066) for measuring acrolein in ambient air provides only 24-hour measurements that cannot be used to estimate the potential acute health risks. Potential acute health risks are estimated using one-hour concentrations. Hourly measurements of acrolein concentrations in ambient air are needed to assess short-term exposure risks.
ARB staff believe that the acrolein measured in ambient air is predominately from motor vehicle exhaust. However, acrolein can also be formed in the atmosphere from chemical reactions involving various hydrocarbons, including 1,3-butadiene. The contribution of acrolein

from secondary emissions due to photooxidation is unknown, but it is suspected to be significant. To better understand the potential contribution of acrolein in ambient air due to photooxidation, it is necessary to take acrolein measurements during the winter and late summer/fall at different times of the day.

PREVIOUS WORK: The Department of Environmental Toxicology, University of California, Davis measured ambient air concentrations of acrolein and other carbonyls at the Oakland-San Francisco Bay Bridge toll plaza. Four-hour measurements of acrolein and other potentially toxic carbonyls in air were sampled during rush hour traffic, which was considered a "worstcase scenario" for outdoor air carbonyls.

OBJECTIVE: The objective is to: 1) evaluate and select and an appropriate test method for measuring hourly concentrations of acrolein in ambient air; 2) the test method's level of detection must be below OEHHA's acute noncancer Reference Exposure Level for acrolein of 0.19 micrograms per cubic meter or 0.09 parts per billion; 3) acrolein concentrations will be measured hourly during winter and late summer/fall at selected sites that are heavily impacted by vehicular traffic and 4) estimate the short-term exposure risks to acrolein at the selected sites.

DESCRIPTION: In consultation with ARB staff, a reliable test method will be selected for measuring hourly concentrations of acrolein in ambient air. The placement of the 1-hour monitors will be based on current sites having the highest 24-hour measurements of acrolein in ambient air. Hourly measurements will be taken in the winter and late summer/fall to evaluate the different hourly/seasonal patterns of acrolein in ambient air. Duplicate samples will be taken for comparison. The maximum 1-hour acrolein concentrations will be used to estimate the potential acute health risks at each site.

BENEFITS: Hourly measurements of acrolein concentrations in ambient air will allow the ARB to estimate the potential acute noncancer health risk from the exposure to acrolein in communities that are impacted heavily by motor vehicle exhaust and help in determining the need to further reduce acrolein emissions. Evaluating the daily/seasonal behavior patterns of acrolein will help in understanding the contribution of acrolein due to secondary formation.

6) TITLE: Characterization of Air Pollution Exposures in Economically Disadvantaged and High Traffic Density Neighborhoods in Los Angeles County, California

PROBLEM: There is currently a lack of neighborhood and individual level air pollution measurements for Californian children that live in high traffic density areas and who may be more susceptible to adverse health impacts from air pollution exposure due to economic disadvantage. Epidemiologic studies focused on assessing health impacts in such populations often have to rely on the existing network of air monitoring stations to assess exposures with all the attendant problems of exposure misclassification and limitation to the routinely measured criteria pollutants including particle mass measurements that focus mainly on larger particles. Although efforts have been and are being made to develop reliable models to assess exposures at a finer spatial scale, additional measurements in Los Angeles (LA) communities with varying amounts of major air pollution sources would help inform and validate these models.

PREVIOUS WORK: Previous studies that have focused on children's respiratory health have not specifically focused on economically disadvantaged areas and have not included communities throughout the entire county. Ralph Deflino at UCI performed extensive air pollutant monitoring of asthmatic children living in high traffic density areas of Los Angeles, however the studies were limited in size and geographic area covered.

OBJECTIVE: The objective is to conduct air pollution monitoring in LA County neighborhoods with varying levels of economic disadvantage and varying exposures to air pollution originating from vehicular sources. These monitoring data will be used in an epidemiologic study of outdoor air pollution and asthma in adults and children ages 0-17 years in conjunction with the L.A. FANS study.

DESCRIPTION: The selection of the communities to be monitored will be based on the Los Angeles Family and Neighborhood Survey (L.A.FANS). This NIH-funded study focuses on 65 neighborhoods throughout the county that were randomly selected from three strata of economic deprivation with oversampling for very poor and poor tracts and for families with children. In these communities various pollutants will be measured over one or two-week periods in each season for a one year period. Thus, there will be detailed, neighborhood level monitoring data for the time period during which asthma outcomes are assessed in the LA FANS children which will be used in analyses of air pollution effects on asthma. The data will also be used in the development of regression models and by other collaborating researchers to inform the development of land use based models of air pollution exposure for use in subsequent epidemiologic studies.

BENEFITS: The findings from this study would help inform policy decisions makers on motor vehicle emissions control and asthma prevention, control and education in low socioeconomic status populations. It would also help in the development of air pollution exposure models that could be used in future epidemiologic studies in LA County focused on different age groups and different adverse health outcomes.

7) TITLE: Effects of Aircraft Ultrafine Particles on Local Air Pollution

PROBLEM: The Los Angeles Basin has the worst air pollution of U.S. urban areas with approximately nine million motor vehicles traveled in 2000 generating more than 10 tons of PM10 per day. In addition to its roadway traffic, Los Angeles is also home to the third largest airport in the world, the Los Angeles International Airport (LAX). LAX handled more than 56 million passengers and 1.9 million tons of goods in 2002 via more than 1200 aircraft carriers per day. These aircraft carriers release large quantities of emissions, particularly ultrafine soot particles. There is little information available on the extent to which aircraft carriers at LAX contribute to the local air pollution of ultrafine particles.

PREVIOUS WORK: Aircraft emit a substantial amount of ultrafine black carbon (BC) particles. Petzold et al. found that particles from aircraft exhaust are primarily BC in a bimodal distribution emitted at rate of about 0.12 g BC / kg fuel. Romano et al. estimate that aircrafts consume 10 to 34 percent of the fuel carried by international (fuel capacity approximately 160,000 kg) and domestic (fuel capacity approximately 60,000 kg) carriers, respectively, at each cycle of landing and takeoff. This leads to about three tons of BC per day being emitted from aircraft landings and takeoffs at LAX in 2003. Compare that to the 10 tons PM10 per day

emitted from motor vehicles across the basin and it is clear that aircraft emissions may play an important role in local air pollution. The aircraft emissions figure is a crude estimate; the issue is largely unstudied, even in recent studies of the air quality management district.

OBJECTIVE: The objective is to comprehensively investigate ultrafine soot particles emitted from aircraft at, and in the vicinity of, LAX. Specific aims include 1) characterizing the source of ultrafine soot particles at LAX; 2) monitoring the particles in the areas around the airport and those under aircraft landing pathways; and 3) differentiating the particles from those emitted from nearby roadways with those from aircraft.

DESCRIPTION: This study will consist of a series of field measurements performed upwind and downwind of the major aircraft operations areas at LAX. Sampling will also be performed in areas where vehicular traffic, both diesel-dominated airport support traffic and roadway traffic may be important. Special emphasis will be placed on time-resolved data collection for black carbon, ultrafine particle counts and size distribution, particle-phase PAH, and combustion gases.

BENEFITS: The significance of this study will contribute to our understanding of the scope of environmental impacts of aircraft ultrafine particles in the vicinity of LAX, which will help to uncover the hidden social costs of operating a major airport in urban areas.

8) TITLE: Mobile Monitoring of Ultrafine Particulate Matter and Related Co-Pollutants in Community, Near-Roadway, and Roadway Locations

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9) TITLE: Factors Affecting School Bus Cabin Air-Tightness and the Relationship Between Air-Tightness and Bus Self-Pollution

PROBLEM: Recent tests of in-cabin air pollution concentrations on board school buses indicate a bus's own exhaust may be infiltrating into the bus cabin in significant quantities under some conditions. To better understand this self-pollution effect and what factors are involved, more study is needed of how and when bus exhaust infiltrates into the cabin, and what factors lead to bus cabins being vulnerable to self-pollution. Measures to reduce bus cabin infiltration (e.g., sealants, maintenance practices, raising the exhaust outlet) may turn out to be a cost-effective means of reducing children's exposures during bus commutes.

PREVIOUS WORK: The recent Children's School Bus Exposure Study (Fitz et al., 2003) found some buses to contribute significantly to their own on-board pollution concentrations. This was determined through the use of SF6 tracer gas added to each bus's exhaust. The extent of the self-pollution appeared to be a function of the bus's own emission rate and the infiltration rate of the bus cabin, although the bus emissions rates were only indirectly measured, so this relationship could not be well quantified. Infiltration rates appeared to increase with bus age and mileage, but bus-to-bus variability was large. The Children's School Bus Exposure Study as well as other in-vehicle studies has also shown closed-window air exchange rates are a strong function of vehicle speed (or air speed).

OBJECTIVE: To better understand the self-pollution effect in school buses by examining what affects bus exhaust infiltration into the cabin and what measures can be used to reduce cabin infiltration.

DESCRIPTION: A representative sample of school buses will be tested for leaks under slight positive pressure to identify the locations, visual conditions, and related characteristics of likely points of exhaust intrusion. The same bus will also have closed-window air exchange rate tests performed at low and zero wind speeds to test the relationship between closed-window air exchange rates and leaks.
A subset of the buses will have exhaust intrusion tests performed using a tracer gas added to the exhaust to see how well self-pollution is related to leak tests and air exchange rates, and to see under what conditions self-pollution seems to be occurring, such as low or zero speeds, sudden decelerations, when bus doors open, or during certain wind directions relative to the

bus. A small subset of the buses showing significant infiltration effects will, where practical, be modified in an attempt to reduce infiltration, and have leak testing and air exchange rate tests repeated. These measures might include new sealing around windows and emergency doors, repair of window latch mechanisms, and raising the exhaust outlet (if safety concerns can be overcome).

BENEFITS: Many school districts cannot afford new buses or particulate trap retrofits. If simple maintenance, specific repairs, or avoidance of certain operating conditions can reduce infiltration of a bus's exhaust and its self-pollution, exposures for children riding older and dirtier buses might be able to be significantly reduced at little or no cost.

10) TITLE: Children's Pollutant Exposures During School Bus Commutes

ABSTRACT

To determine the range of children's exposures during their bus commutes, especially those conditions leading to high exposures, real-time and integrated measurements of pollutant concentrations were conducted inside five conventional diesel school buses, as well as a diesel bus outfitted with a particulate trap and a bus powered by natural gas. Measurements were made during 20 bus commutes on a Los Angeles Unified School District bus route from South Central Los Angeles to the west side of LA, with additional runs on a second urban route, a rural/suburban route, and to test the effect of window position. Children's school bus commutes in Los Angeles appear to expose them to significantly higher concentrations of vehicle-related pollutants than ambient air concentrations and frequently higher concentrations than those measured on roadways. Concentrations of diesel vehicle-related pollutants such as black carbon and particle-bound PAHs were significantly higher on board conventional diesel buses when windows were closed. This was due to the intrusion of the bus's own exhaust, as demonstrated through the use of a tracer gas added to each bus's exhaust. When windows were open, increased ventilation rates markedly reduced this effect, although high peak concentrations were then observed when following other diesel vehicles. On-board concentrations of vehicle-related pollutants were also significantly higher on the urban routes compared to the rural/suburban route, indicating the importance of surrounding traffic density. Other related exposure scenarios such as bus loading and unloading, and time spent waiting at bus stops, were shown to make relatively insignificant contributions to children's exposure, due to the generally lower concentrations and the short times spent at those activities compared to bus commutes. Results from this study show that minimizing commute times, using the cleanest buses for the longest routes, and reducing bus caravanning and idling time will reduce children's exposure to bus-related pollutants.

Link to Full Report: ftp://ftp.arb.ca.gov/carbis/research/apr/past/00-322.pdf